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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to a metal surface treatment equipment train.

[0002]

[Description of the Prior Art] Conventionally, the mechanical descaling method which grinds an ingredient front face as a descaling method of steel materials with KEMIKARU descaling by the acid, shot blasting, a brush, or a grinding stone is learned.

[0003] Setting to carbon steel, a scale is $\text{FeO/Fe}_3\text{O}_4 / \text{Fe}_2\text{O}_3$. It consists of three layers and the scale consists of a firm oxide containing Cr in stainless steel.

[0004] Conventionally, descaling of these steel materials was made by processing with an acid, and its process on antipollution measures, such as waste-acid processing, was indispensable. On the other hand, to difficult steel materials, descaling, such as stainless steel, needed to use strong acid, such as a nitric acid and fluorine acid, and was obliged to difficult processings, such as processing of the gas which occurs with descaling processing, and processing of a waste acid.

[0005] Moreover, according to the conventional acid washing, the scale is obliged to reprocessing by the so-called bite, and especially removal of scales, such as lump scale and ****, is difficult, and according to acid pile scarfing deeply blown on the metal base, or the heavy duty grinding by the grinder, and caused a cost rise. On the other hand, when shot blasting performed descaling of steel materials, the effectiveness of descaling is low, and removal of a scale (oxide) was not made completely but had problems, such as generating of dust and an abrasive grain powder residual on the front face of a product where removal is difficult, again.

[0006] The method of dissolving and evaporating the scale on the front face of steel materials with the application of an electron beam, a laser beam, and a discharge arc, on a steel-materials front face as a descaling method of the hot-rolled steel strip, is indicated by JP,57-56109,A. However, when based on this approach, a lot of power was needed and there was a problem from a viewpoint of energy saving.

[0007]

[Problem(s) to be Solved by the Invention] This invention offers the continuation surface treatment equipment train of the steel materials of the energy-saving mold from which the scale of a surface of metal is efficiently removable with the discharge arc in a vacuum.

[0008]

[Means for Solving the Problem] The place by which it is characterized [of this invention] in the conveyance system of processed material A lightly pressurizing mill, a bending roll, One or more sorts in shot blasting, a grinder, and a light acid pickling unit are arranged. The vacuum processing room which opposite-****(ed) the hyperfractionation electrode arranged crosswise [of processed material] on both sides of the pass line of said processed material and the conductor roll is established in this lower stream of a river. It is in the continuation surface treatment equipment train of the metal characterized by furthermore arranging one or more sorts in a coil grinder, a light acid pickling unit, and a brassie roll in

this lower stream of a river.

[0009] Hereafter, this invention is explained to a detail. According to this invention, the impurity of the front face of strips, such as iron and a nonferrous metal, a wire, tubing, and a molded product (processed material is called hereafter.) and an oxide are effectively [continuously and] removable.

[0010] In this invention, arc discharge is performed by processed material and inter-electrode in the vacuum of 1 - 10⁻³Torr, and the impurity and scale of a processed material front face are removed continuously and efficiently. A vacuum arc begins from the place which has a scale (metallic oxide) first, if a scale is removed and a surface of metal appears by electric evaporation, an arc will not fly to a surface of metal, but it will move to the small scale section of a work function, and discharge will start. In atmospheric pressure discharge or underwater discharge, although the luminescent spot (arc spot) is made by only one piece in cathode and an anode plate, in a vacuum, many very small arc spots occur in cathode, and since these move about at random violently, removal of a scale is made quickly.

[0011] this invention persons did the knowledge not only of the surface of a processed material but generally [the metallic oxide deeply blown to a metal base, or surface ****] the difficult scale of removal etc. being preferentially [efficiently and] removable from a surface, when vacuum arc discharge was performed, as a result of repeating the research accompanied by various experiments. Processed material can also adjust the shape of front planarity, such as roughness, free by performing many electrotreatment, although considering as a product as it is also possible since it has the shape of outstanding front planarity.

[0012] Next, when added lightly pressurizing rolling with a 2 - multistage roll etc., and/or repeat bending by the bending roll to processed material, and the minute crack was positively given in advance of vacuum arc discharge, and/or shot blasting and/or rough descaling by the grinder were performed and it ***** (ed) if needed further, the work relation of vacuum arc discharge fell and the knowledge of vacuum arc discharge being effectively performed with fewer power was carried out.

[0013] furthermore, when it continued at vacuum arc discharge and ***** processing for less than several minutes be performed with surface conditioning and/or a sulfuric acid with comparatively low concentration, or a hydrochloric acid by the coil grinder etc., while remove a low melting coagulation layer, same grain, etc. of the crater-like irregularity of the descaling section by which have be form of vacuum arc discharge, or corrosion resistance bad Cr concentration, surface roughness also became small and carried out the knowledge of outstanding descaling be possible.

[0014] In addition, although it may face applying lightly pressurizing rolling to processed material and 2 - multistage any are sufficient as a roll, although the path of a work roll is as much as possible small, the direction is more effective [the path]. Moreover, the bending roll has the structure where vertical roll spacing which was also called the roller leveler, is between the upper and lower sides and arranged the 4-9 roll in zigzag can be adjusted. With a bending roll, it faces giving bending repeatedly to processed material, and vertical roll spacing is changed according to board thickness to make it a crack enter effective in the scale of a processed material front face.

[0015] On the other hand, shot blasting projects a cut wire or a steel shot on a steel-materials front face at the high speed of 50 - 60 m/sec by the centrifugal force of an impeller, and removes a surface scale. Of course, wet shot blasting can also be used.

[0016] Grinding is the approach the grinding stone which rotates at high speed removes the surface scale or irregularity of processed material. the grinding stone part rotated as a grinder -- oil pressure -- front and rear, right and left -- it moves to both, can repair now anywhere on the front face of an ingredient, and is used for local crack care and cleaning.

[0017] In this invention, making surface roughness of material small using a belt sander etc. as [vacuum arc descaling (descaling by vacuum arc discharge)], and being formed in a steel-materials front face of vacuum arc descaling in the case of stainless steel can also apply a coil grinder also to removing effectively the melting coagulation layer in which a certain Cr concentration is inferior to corrosion resistance low.

[0018] Acid washing is immersed in acid liquid, such as a sulfuric acid, a hydrochloric acid, a nitric acid, phosphoric acid, and fluoric acid, and is performed. Although a cheap sulfuric acid is generally

used widely, a hydrochloric acid has the advantage which can remove a scale quickly in ordinary temperature. An inhibitor is added by acid pickle in order to prevent fault acid washing of life increase of acid liquid, and a product.

[0019] It is prepared in the outlet in acid washing or electric clarification Rhine, and the brassie roll which made the ring of the brush or the brush of a fiber construct is known as a roll which rubs a sordes off. If according to the experiment a brassie roll is included in the equipment train of this invention and used together, it is effective in surface roughness adjustment of the high-class form of stainless steel etc., for example, mirror plane finishing can be acquired.

[0020]

[Example]

(Example 1) In drawing 1 and drawing 5, the vacuum control room 13-1 and 13-2 are arranged in the vacuum processing room 12 at a close and appearance side, respectively, and it is always maintained by the pressure (degree of vacuum) of 1 - 10-3Torr. Moreover, an electrode 21 and the conductor roll 22 are opposite-*(ed) by the vacuum processing room 12 on both sides of the pass line of processed material, and an electrode and a conductor roll are arranged in the transit direction of processed material by turns. The electrode 21 has the structure where the electrode by which hyperfractionation was carried out extends crosswise [of processed material], as shown in drawing 2, and discharge mode is given to each unit electrode individually and alternatively. Discharge mode consists of the potential difference of a current, an electrical potential difference, magnetic field strength, a direction, processed material, and an electrode etc., and is beforehand given from a computer for every processed material.

[0021] The processed material 20 (steel strip) is introduced into the vacuum processing room 12, after the 4 corrugating rolls 14 are supplied from the pulling roll 9-1 and lightly pressurizing rolling is carried out there. As for the rolling reduction in lightly pressurizing rolling made by said 4 corrugating rolls 14, considering as 0.5% or more is desirable. However, the effectiveness of lightly pressurizing rolling is saturated with 5%.

[0022] In drawing 1 and drawing 5, 26 is a vacuum arc controller and 27 is a computer. In a computer 27, based on information, such as thickness of the quality of the material of the processed material 20, or a surface oxide film, extent of dirt, and a cross-section dimension of the processed material 20, operation calculation of the current value in an electrode, an electrical potential difference, magnetic field strength, the direction, etc. is carried out, and said each set point is given according to two or more electrode individuals. These set points are controlled by the controller 26 that the value should be maintained.

[0023] The processed material 20 processed at this vacuum processing room 12 can also be considered as a product as it is. Moreover, it is also possible by considering as many electrodes to adjust the surface roughness of the processed material 20 processed at the vacuum processing room 12. Furthermore, in addition to processing at the vacuum processing room 12, acid washing was performed by *****. In ***** 29-1, sulfuric-acid liquid with comparatively low concentration (300g [L.] sulfuric acid) performed acid treatment for less than 5 minutes.

[0024] Drawing 3 - drawing 4 show the process of smoothing of the processed material processed by the continuation surface treatment equipment train of this invention. After the scale 23 of drawing 3 and the processed material 20 of 4 (a) is made to produce a crack 24 with 4 corrugating rolls and/or a bending roll and rough descaling is performed to it by/or shot blasting (drawing 3, 4 (b)), it can irradiate a discharge arc at the vacuum processing room 12, and receives primary treatment. A scale 23 is removed and forms the front planarity-like level L1 by the roughness and fineness of the discharge arc 25 (drawing 3, 4 (c)). Subsequently, secondary treatment is received, the heights after descaling are fused, and level L2 graduates (drawing 3, 4 (d)). Furthermore, level L3 is formed by ***** and the outstanding surface roughness is obtained.

[0025] 0.2% of rolling reduction was applied in lightly pressurizing rolling by the 4 corrugating rolls 14. the case where the processed material 20 is stainless steel (19Cr-0.6Nb steel hot-rolling plate) -- processing speed -- 10-50mpm it is -- although -- this invention -- setting -- injection power -- 1 kW-Hr-m2 Descaling was completely performed by setting up. Generally [surface **** etc.] it was checked that descaling of the part where removal is difficult is also made completely. Surface roughness is like

$R_{max}=12\text{micrometer}$ and $R_a=1.5\text{micrometer}$, and the shape of front planarity which was very excellent was able to be acquired. The corrosion resistance bad tub with low Cr concentration is also completely removable.

[0026] As an example of a comparison, when the direct processed material 20 was supplied to the vacuum processing room 12, descaling was tried and the processed material 20 was stainless steel (19Cr-0.4Nb steel hot-rolling plate), without performing lightly pressurizing rolling by 4 corrugating rolls in the process shown in drawing 5, the injection power required for carrying out descaling completely was the injection power of 2.2 kW-Hr/m^2 .

[0027] Moreover, when direct plate leaping of the processed material 20 was carried out to ***** 29 in drawing 5, without letting the vacuum processing room 12 pass, in the case of said stainless steel (19Cr-0.6Nb steel hot-rolling plate), descaling did not completely have a limping gait crack.

[0028] When not letting ***** 29 pass for the processed material 20 in drawing 5, the surface roughness of said stainless steel is $R_{max}=13\text{micrometer}$ and $R_a=1.6\text{micrometer}$, and is comparable as an example, but irregularity is steep, and since it may become surface nonuniformity when cold-rolling is carried out, the shape of front planarity is inferior to an example.

[0029] (Example 2) Using the equipment train shown in drawing 6, the processed material 20 was supplied to the vacuum processing room 12 through the bending roll 15, descaling processing was performed, and plate leaping was further carried out to ***** 29.

[0030] A bending roll 15 gives four repeat bending to the processed material 20, and repeated and gave bending of 200mR to the processed material 20 (19Cr(s)-0.6Nb stainless steel hot-rolling plate of 3.8mm thickness). the injection power taken to carry out descaling of them completely although other processing conditions were the same in the example 1 -- 0.9 kW-Hr/m^2 it was . ***** conditions are processings for less than 5 minutes in a 300g [l.] sulfuric acid. Surface roughness is $R_{max}=11\text{micrometer}$ and was able to acquire the shape of front planarity which was very excellent.

[0031] (Example 3) Using the equipment train respectively shown in drawing 7 -15, the processed material 20 was supplied to the vacuum processing room 12 through at least one of the 4 corrugating rolls 14, a bending roll 15, shot blasting 17, a grinder 16, or the acid-washing equipment 18, and descaling processing was performed. Furthermore, plate leaping was carried out to at least one of ***** 29, the coil grinder 28, or the brassie rolls 30 as after treatment. A test condition and a test result are collectively shown in Table 1.

[0032] In shot blasting 17, the steel shot was projected on processed material at the high speed of 50 m/sec . The coil grinders 16 and 28 used the belt-like sandur. The brassie roll 30 used the brush-like thing. Other conditions were the same as the example 1 and the example 2.

[0033] It also sets in which equipment train of this invention, and the injection power required for carrying out descaling completely is 1 kW-Hr/m^2 . It is the following and descaling was made very effectively. Surface roughness is R_{max} . It evaluates, and in Table 1, it is O about 10 micrometers or more 15 micrometers, and O shows less than 10 micrometers.

[0034]

[Table 1]

| 実施例 | 前処理 | 真空アーク 処理電力 (kW・Hr/m ²) | 後処理 | デスク性 | 表面粗度 Rmax (μ m) | 図面 |
|------|------------------------------|--|-------------|------|----------------------------|----|
| A | 軽圧下ミル | 1 | 軽酸洗 | 良好 | ○ | 5 |
| B | ペンディング・ロール | 0.9 | 軽酸洗+ブラッシロール | 良好 | ○ | 6 |
| C | 軽圧下ミル+ペンディング・ロール | 0.7 | 軽酸洗 | 良好 | ○ | 7 |
| D | ショット・ブラスト | 0.8 | コイルグラインダー | 良好 | ○ | 8 |
| E | ショット・ブラスト | 0.8 | 軽酸洗 | 良好 | ◎ | 9 |
| F | グラインダー | 0.7 | 軽酸洗 | 良好 | ◎ | 10 |
| G | ショット・ブラスト+グラインダー | 0.3 | 軽酸洗+ブラッシロール | 良好 | ◎ | 11 |
| H | ペンディング・ロール+ショット・ブラスト | 0.5 | ブラッシロール | 良好 | ◎ | 12 |
| I | ペンディング・ロール+軽酸洗 | 0.4 | ブラッシロール | 良好 | ◎ | 13 |
| J | ショット・ブラスト+軽酸洗 | 0.4 | ブラッシロール | 良好 | ◎ | 14 |
| K | ペンディング・ロール +ショット・ブラスト+軽酸洗 | 0.3 | ブラッシロール | 良好 | ◎ | 15 |
| 比較例1 | 前処理なし | 2.2 | 軽酸洗 | 良好 | ○ | |
| 比較例2 | 軽圧下ミル | 1 | 後処理なし | 不良 | — | |

[0035]

[Effect of the Invention] Since this invention was made to perform processing which applies a discharge arc at the vacuum processing room 12 after putting a crack into the scale of a processed material front face beforehand, or after performing rough descaling by mechanical DESUKE, it can make injection power a small thing and can make a manufacturing cost cheap. Since this invention performs overall descaling by vacuum arc discharge and performs coil grinding or/and surface conditioning by ***** processing further, it can obtain the front planar product which was very excellent.

[0036] Since it can remove effectively the scale partially buried with the front face of processed material, the scale of the crack section, or the residual scale by mechanical DESUKE with a discharge arc, extremely excellent descaling is possible for this invention, its yield can improve by leaps and bounds, and it can make a manufacturing cost low. Moreover, as compared with descaling by acid washing, a facility installed cost can be made low, and also it does big effectiveness so industrially that the load of large compaction of the processing time and waste-acid processing is sharply mitigable etc.

[Translation done.]